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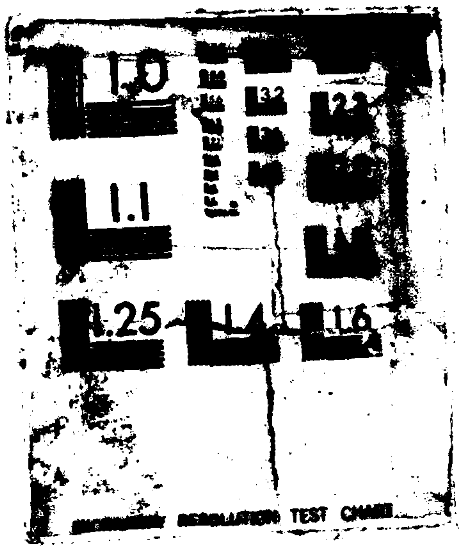
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FINAL TECHNICAL REPORT -- CONTRACT N00014-85-K-144

SEAMOUNT EVOLUTION AND DISTRIBUTION OF YOUNG SEAMOUNTS ALONG THE EAST PACIFIC RISE BETWEEN 20 N AND 20 S

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Long-Range Scientific Objectives

To understand the mechanisms involved in seamount evolution, including constructional volcanic processes, magma genesis, and tectonic and erosional modification of constructional terrain. To understand the relationships between seamount volcanism and temporal and spatial evolution of accretionary plate boundary structure and magmatic budget.

Project Objectives

1. Development of valid models that accurately describe seamount evolutionary processes; the types of terrain likely to be found on a seamount of given age and tectonic locale, and the implications that seamount development have for understanding magmatic cycles along accretionary boundaries.

2. Acquire an understanding of the magmatic evolution that many seamounts experience during their growth and whether seamount magmatism is controlled in part by accretionary magmatic cycles.

3. Understand the structural deformation of seamounts as controlled by inflation and deflation of shallow-level magma chambers and conduits within and underneath the volcano, and how these processes affect volcano evolution and morphology.

4. Understand the distribution of young seamounts along the East Pacific Rise axis between 20 N and 20 S as deduced from Sea Beam multibeam sonar data.

Current Status

1) During January of 1983 a detailed survey, funded by ONR, was conducted using Sea Beam and Sea MARC I sonars of a seamount group near the East Pacific Rise at 09 53'N.

2) Subsequent to the acquisition and analysis of the multibeam and side-looking sonar data a field program using DSRV ALVIN (funded by NSF) was carried out on the five seamounts in this group during May 1985.

3) As part of the ALVIN program, ONR funded a deep sea camera program of 7 tows in various locales on and around these seamounts.

4) During 1984 and 1985 a systematic analysis of all available Sea Beam data was carried out (in conjunction with Dr. Rodey Batiza) in order to map and catalog the distribution of young seamounts along the East Pacific Rise between 20 N and 20 S. This study was designed to build a digital data set of seamount locations and characteristics, and relate them to accretionary boundary characteristics so that extensive cross-correlations could be carried out.

Progress to Date

Young seamounts near the East Pacific Rise appear to undergo a morphological and structural evolution that is largely tied to the development of shallow-level magma reservoirs and conduits under and within the volcanoes. Sea Beam, Sea MARC I and ALVIN data all show that seamount craters and calderas are active environments where recent volcanism is localized and where structural deformation of the seamount top takes place. Abundant evidence for ring fractures, localized around the summit caldera, have been found in both the side-looking sonar and ALVIN data on all of the seamounts studied except the youngest, Sasha. These ring fractures are the vents for most of the recent, post-caldera collapse volcanism observed on these volcanoes.
The abundance of small parasitic cones around the base of many seamounts suggests that these small volcanic constructs act as "relief valves" which drain away magmas that may otherwise erupt on a seamount summit. In addition, it appears that the height to which a seamount can grow is controlled by a pressure-sensitive equilibrium between eruptive pressure and water and rock overburden pressure. Often times small cones are localized along faults that are subparallel to the rise axis thereby suggesting that the subsurface continuations of these faults act as conduits for magmas in sub-ridge magma chambers or that they possibly tap seamount magma chambers or conduits.
All rocks recovered from the seamount group studied at 09 53'N are tholeiitic basalts with no transitional or alkalic rocks present, even in the oldest volcanoes (NEW and DTD) which are approximately 700,000 years old. The rock chemistry indicates that post-caldera collapse volcanism is still actively being fed by magma sources located in the upper mantle, and hence the chamber/conduit system beneath each volcano is not stagnating. The deformation field implied by the caldera and/or crater on each seamount summit suggests that each volcano has a separate feeder system that inflates and deflates independently. Ongoing chemical analyses suggest that there are minor but discrete differences between the lavas of each volcano and that important chemical differences exist between lavas erupted on the East Pacific Rise adjacent to this seamount group and seamount lavas. These chemical differences preclude the supply of seamount magmas from subridge magma chambers and therefore place constraints on the dimensions of the subridge magma chamber around 09 53'N. In this case the magma chamber probably does not extend beyond 5 km from the ridge axis on the west side of the crest. Based on the morphology of the ridge crest the magma chamber may be asymmetrical in cross section with respect to the ridge axis; with the west side being wider than the east.

Regional compilation and study of over 10,000 line kilometers of Sea Beam data, for information on young seamount distribution along the East Pacific Rise between 20 S and 20 N shows the following relationships at this time:

1. Seamount distribution appears to be controlled by the presence of fracture zones or large transforms.
2. Seamount distribution appears not to be controlled by overlapping spreading centers currently found along the East Pacific Rise between 20 N and 20 S.
3. Young seamounts are most abundant proximal to areas along the East Pacific Rise crest that are shallow (<2650 meters depth). This supports the hypothesis that shallow crestal segments of the East Pacific Rise are the sites of most recent magmatic activity and as such there may be a greater chance to have "excess" aesthenospheric magma at these areas that can supply seamount magmatism and lead to the creation of volcanoes off-axis.

Analysis of these data is ongoing. We are presently applying some statistical rigor to the cross-correlations in order to remove sampling bias introduced by Sea Beam track distribution. In addition, we are correlating a variety of structural and morphological characteristics (e.g. caldera volume, rift zone and satellite cone orientation) within the data set to determine whether we can isolate any factors that control these characteristics (e.g. volcano size).

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